

WHAT IS CLAIMED IS:

1. An information recording medium for recording a real-time file containing real-time data in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file; the real-time data is recorded in at least two real-time extents each of which is allocated in logically contiguous sectors within the volume space; and

an $(i+1)^{\text{th}}$ real-time extent among the at least two real-time extents is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{\text{out}},$$

wherein:

$T(i)$ represents a time required for the pickup to access from an end of an i^{th} real-time extent among the at least two real-time extents to a beginning of the $(i+1)^{\text{th}}$ real-time extent;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} real-time extent to the beginning of the $(i+1)^{\text{th}}$ real-time extent, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} real-time extent, such that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from each of the at least two real-time extents by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} real-time extent.

2. An information recording medium according to claim 1, wherein $D(i)$ is corrected so that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in} + B(i-1) - k \times (V_{out} \times T_k)$ when $D(i) > M - B(i-1)$, wherein:

T_k represents a maximum rotation wait time of the information recording medium; and

k represents an integer portion of $((D(i) + B(i-1) - M) / (V_{out} \times T_k) + 1)$.

3. An information recording medium according to claim 1, wherein each of the at least two real-time extents is allocated in physically contiguous sectors.

4. An information recording medium according to claim 1, wherein the file management information comprises location information indicating each of the at least two real-time extents.

5. An information recording medium according to claim 1, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

6. An information recording medium according to claim 1, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

7. An information recording medium according to claim 1, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

8. An information recording medium for recording a real-time file containing real-time data in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file; the real-time data is recorded in at least two real-time extents each of which is allocated in logically

2025 RELEASE UNDER E.O. 14176

contiguous sectors within the volume space; and

an $(i+1)^{\text{th}}$ real-time extent among the at least two real-time extents is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{\text{out}},$$

wherein:

$T(i)$ represents a time required for the pickup to access from an end of an i^{th} real-time extent among the at least two real-time extents to a beginning of the $(i+1)^{\text{th}}$ real-time extent;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} real-time extent to the beginning of the $(i+1)^{\text{th}}$ real-time extent, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} real-time extent, such that $D(i) = (V_{\text{in}} - V_{\text{out}}) \times S(i) / V_{\text{in}}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from each of the at least two real-time extents by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} real-time extent,

wherein the real-time file is a file in which the real-time data is appended; and

wherein data of an already recorded real-time extent is recorded in a newly recorded real-time extent.

9. An information recording medium according to claim 8, wherein $D(i)$ is corrected so that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in} + B(i-1) - k \times (V_{out} \times T_k)$ when $D(i) > M - B(i-1)$, wherein:

T_k represents a maximum rotation wait time of the information recording medium; and

k represents an integer portion of $((D(i) + B(i-1) - M) / (V_{out} \times T_k) + 1)$.

10. An information recording medium according to claim 8, wherein each of the at least two real-time extents is allocated in physically contiguous sectors.

11. An information recording medium according to claim 8, wherein the file management information comprises location information indicating each of the at least two real-time extents.

12. An information recording medium according to claim 8, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

13. An information recording medium according to claim 8, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

14. An information recording medium according to claim 8, wherein the file management information comprises, as an extended attribute, information representing a condition

1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100	2101	2102	2103	2104	2105	2106	2107	2108	2109	2110	2111	2112	2113	2114	2115	2116	2117	2118	2119	2120	2121	2122	2123	2124	2125	2126	2127	2128	2129	2130	2131	2132	2133	2134	2135	2136	2137	2138	2139	2140	2141	2142	2143	2144	2145	2146	2147	2148	2149	2150	2151	2152	2153	2154	2155	2156	2157	2158	2159	2160	2161	2162	2163	2164	2165	2166	2167	2168	2169	2170	2171	2172	2173	2174	2175	2176	2177	2178	2179	2180	2181	2182	2183	2184	2185	2186	2187	2188	2189	2190	2191	2192	2193	2194	2195	2196	2197	2198	2199	2200	2201	2202	2203	2204	2205	2206	2207	2208	2209	2210	2211	2212	2213	2214	2215	2216	2217	2218	2219	2220	2221	2222	2223	2224	2225	2226	2227	2228	2229	2230	2231	2232	2233	2234	2235	2236	2237	2238	2239	2240	2241	2242	2243	2244	2245	2246	2247	2248	2249	2250	2251	2252	2253	2254	2255	2256	2257	2258	2259	2260	2261	2262	2263	2264	2265	2266	2267	2268	2269	2270	2271	2272	2273	2274	2275	2276	2277	2278	2279	2280	2281	2282	2283	2284	2285	2286	2287	2288	2289	2290	2291	2292	2293	2294	2295	2296	2297	2298	2299	2300	2301	2302	2303	2304	2305	2306	2307	2308	2309	2310	2311	2312	2313	2314	2315	2316	2317	2318	2319	2320	2321	2322	2323	2324	2325	2326	2327	2328	2329	2330	2331	2332	2333	2334	2335	2336	2337	2338	2339	2340	2341	2342	2343	2344	2345	2346	2347	2348</
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	--------

wherein the playback reference model includes:

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file; the real-time data is recorded in at least two real-time extents each of which is allocated in logically contiguous sectors within the volume space; and

$$T(i) \leq (B(i-1) + D(i))/V_{out},$$

T(i) represents a time required for the pickup to access from an end of an i^{th} real-time extent among the at least two real-time extents to a beginning of the $(i+1)^{\text{th}}$ real-time extent:

B(i) represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} real-time extent to the beginning of the $(i+1)^{\text{th}}$ real-time extent, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times$

$T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} real-time extent, such that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from each of the at least two real-time extents by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} real-time extent,

wherein the real-time file is a file in which the real-time data is appended;

wherein the real-time data is compressed in an MPEG format; and

wherein data comprising one or more GOPs recorded at an end of the real-time file before appending is re-encoded and is recorded in a newly recorded real-time extent.

16. An information recording medium according to claim 15, wherein $D(i)$ is corrected so that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in} + B(i-1) - k \times (V_{out} \times T_k)$ when $D(i) > M - B(i-1)$, wherein:

T_k represents a maximum rotation wait time of the information recording medium; and

k represents an integer portion of $((D(i) + B(i-1) - M) / (V_{out} \times T_k) + 1)$.

17. An information recording medium according to claim 15,

wherein each of the at least two real-time extents is allocated in physically contiguous sectors.

18. An information recording medium according to claim 15, wherein the file management information comprises location information indicating each of the at least two real-time extents.

19. An information recording medium according to claim 15, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

20. An information recording medium according to claim 15, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

21. An information recording medium according to claim 15, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

22. An information recording medium comprising a volume space for at least recording in sectors a file comprising data and file management information for managing the file, wherein:

the data comprises real-time data, the real-time data comprising at least one of video data and audio data;

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous

2025 RELEASE UNDER E.O. 14176

a linking gap is formed in the at least one real-time extent.

the real-time data is recorded in the runout area within

the linking loss extent.

28. A method for recording a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data, wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous sectors within the volume space,

wherein the method comprises the steps of:

searching for at least two areas satisfying a real-time reproduction condition from among a plurality of logically contiguous unused areas within the volume space, each of the at least two areas being designated as a pre-allocated area, an (i+1)th pre-allocated area among the at least two areas satisfying the real-time reproduction condition being defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{out},$$

wherein:

T(i) represents a time required for the pickup to access from an end of an ith pre-allocated area among the at least two pre-allocated areas to a beginning of the (i+1)th

pre-allocated area;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} pre-allocated area to the beginning of the $(i+1)^{\text{th}}$ pre-allocated area, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} pre-allocated area, such that $D(i) = (V_{\text{in}} - V_{\text{out}}) \times S(i) / V_{\text{in}}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from the pre-allocated area by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} pre-allocated area;

recording the real-time data in the pre-allocated area;

designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent; and

recording the file management information for managing the real-time data as the real-time file.

29. A method according to claim 28, wherein $D(i)$ is corrected so that $D(i) = (V_{\text{in}} - V_{\text{out}}) \times S(i) / V_{\text{in}} + B(i-1) - k \times (V_{\text{out}} \times T_k)$ when $D(i) > M - B(i-1)$, wherein:

T_k represents a maximum rotation wait time of the information recording medium; and

k represents an integer portion of $((D(i) + B(i-1) - M) / (V_{\text{out}} \times T_k) + 1)$.

30. A method according to claim 28, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an ECC block-by-ECC block basis.

31. A method according to claim 28, wherein the file management information comprises location information indicating each of the at least two real-time extents.

32. A method according to claim 28, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

33. A method according to claim 28, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

34. A method according to claim 28, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

35. A method for recording a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data, wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for

temporarily storing the real-time data read by the pickup;
and a decoder module for reading the real-time data from
the buffer memory for processing,

wherein the information recording medium comprises a
volume space for at least recording in sectors a file
comprising data and file management information for managing
the file,

the real-time data is recorded in at least one real-time
extent each of which is allocated in logically contiguous
sectors within the volume space,

wherein the method comprises the steps of:

calculating whether or not each of the at least one
real-time extent will cause an overflow in an amount of data
stored in the buffer memory if the real-time extent is
reproduced by the playback reference model;

when it is calculated that the real-time extent will
cause an overflow, correcting the amount of data stored in
the buffer memory to equal to or smaller than the size of
the buffer memory;

calculating whether or not an underflow will occur in
the amount of data stored in the buffer memory if the playback
reference model accesses from the real-time extent to a
newly-allocated pre-allocated area;

when it is calculated that an underflow will occur,
searching for a real-time extent which will not cause an
underflow, on accessing from the real-time extent to the
pre-allocated area;

recording in the newly-allocated pre-allocated area the
real-time data already recorded in the real-time extent
which will cause an underflow;

recording real-time data to be appended in the
newly-allocated pre-allocated area;

designating a set of logically contiguous sectors in

2025 RELEASE UNDER E.O. 14176

which real-time data is recorded as a real-time extent; and recording the file management information.

36. A method according to claim 35, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an ECC block-by-ECC block basis.

37. A method according to claim 35, wherein the file management information comprises location information indicating each of the at least one real-time extent.

38. A method according to claim 35, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

39. A method according to claim 35, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

40. A method according to claim 35, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extent were positioned.

41. A method for appending a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data, wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous sectors within the volume space,

wherein the real-time file comprises data which is compressed in an MPEG format,

wherein the method comprises the steps of:

reading data recorded at an end of the real-time file before appending, the data comprising one or more GOPs;

re-encoding the data which has been read;

recording the re-encoded data in a newly allocated pre-allocated area;

recording real-time data to be appended in the newly-allocated pre-allocated area;

designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent; and

recording the file management information.

42. A method according to claim 41, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an ECC block-by-ECC block basis.

43. A method according to claim 41, wherein the file management information comprises location information indicating each of the at least one real-time extent.

44. A method according to claim 41, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

45. A method according to claim 41, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

46. A method according to claim 41, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

47. A method for recording information on an information recording medium comprising a volume space for at least recording in sectors a file comprising data and file management information for managing the file, comprising the steps of:

determining whether or not the file is a real-time file containing real-time data;

recording the file management information in the volume space;

recording the real-time data next to a linking loss extent if the file is determined to be a real-time file; and

responsive to a buffer underrun occurring during the recording of the real-time data, forming a linking gap in a real-time extent in which the real-time data is recorded.

48. A method according to claim 47, wherein the linking loss extent comprises one ECC block.

49. A method according to claim 47, wherein the file management information comprises location information indicating each real-time extent.

50. A method according to claim 47, wherein the file management information comprises identification information for identifying the real-time file including real-time data.

51. A method according to claim 47,
wherein a data type bit is recorded in an area for recording physical additional information concerning each sector within the linking loss extent, the data type bit being used for identifying the linking loss extent; and
wherein the data type bit for the sector is set to 1 if a next sector is included within the linking loss extent, unless the sector is a linking sector.

52. A method according to claim 47, further comprising a step of recording the real-time data in a runout area within the linking loss extent.

53. An information recording apparatus for recording a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the

information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file;

wherein the information recording apparatus comprises a file system processing section for: allocating at least two areas satisfying a real-time reproduction condition from among a plurality of logically contiguous unused areas within the volume space, each of the at least two areas being designated as a pre-allocated area; recording the real-time data and the file management information; designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent; and generating the file management information for managing the real-time data as the real-time file.

wherein an (i+1)th pre-allocated area among the at least two pre-allocated areas is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{out},$$

wherein:

T(i) represents a time required for the pickup to access from an end of an i^{th} pre-allocated area among the at least two pre-allocated areas to a beginning of an $(i+1)^{\text{th}}$ pre-allocated area among the at least two pre-allocated areas;

B(i) represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} pre-allocated area to the beginning of the $(i+1)^{\text{th}}$ pre-allocated area, such that $B(i) = B(i-1) + D(i) - V_{\text{out}}$

$\times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} pre-allocated area, such that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from the pre-allocated area by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} pre-allocated area.

54. An information recording apparatus according to claim 53, wherein $D(i)$ is corrected so that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in} + B(i-1) - k \times (V_{out} \times T_k)$ when $D(i) > M - B(i-1)$, wherein:

T_k represents a maximum rotation wait time of the information recording medium; and

k represents an integer portion of $((D(i) + B(i-1) - M) / (V_{out} \times T_k) + 1)$.

55. An information recording apparatus according to claim 53, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an ECC block-by-ECC block basis.

56. An information recording apparatus according to claim 53, wherein the file management information comprises location information indicating each real-time extent.

57. An information recording apparatus according to claim 53, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

58. An information recording apparatus according to claim 53, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

59. An information recording apparatus according to claim 53, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

60. An information recording apparatus for appending a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing

2025 RELEASE UNDER E.O. 14176

the file,

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous sectors within the volume space,

wherein the information recording apparatus comprises:

a data amount calculation section for calculating whether or not each of the at least one real-time extent will cause an overflow in an amount of data stored in the buffer memory if the real-time extent is reproduced by the playback reference model; correcting the amount of data stored in the buffer memory to equal to or smaller than the size of the buffer memory when it is calculated that the real-time extent will cause an overflow; calculating whether or not an underflow will occur in the amount of data stored in the buffer memory if the playback reference model accesses from the real-time extent to a newly-allocated pre-allocated area; and searching for a real-time extent which will not cause an underflow, on accessing from the real-time extent to the pre-allocated area when it is calculated that an underflow will occur;

a data recording section for recording in the newly allocated pre-allocated area the real-time data already recorded in the real-time extent which will cause an underflow, and recording real-time data to be appended in the newly-allocated pre-allocated area; and

a file structure processing section for designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent and for generating and recording the file management information.

61. An information recording apparatus according to claim 60, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an

ECC block-by-ECC block basis.

62. An information recording apparatus according to claim 60, wherein the file management information comprises location information indicating each of the at least one real-time extent.

63. An information recording apparatus according to claim 60, wherein the file management information comprises first identification information for identifying the real-time file including real-time data.

64. An information recording apparatus according to claim 60, wherein the file management information comprises second identification information for indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition.

65. An information recording apparatus according to claim 60, wherein the file management information comprises, as an extended attribute, information representing a condition under which the at least two real-time extents were positioned.

66. An information recording apparatus for appending a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for

20250909 09:00:00

temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous sectors within the volume space,

wherein the real-time file comprises data which is compressed in an MPEG format,

wherein the information recording apparatus comprises:

a re-encoding section for reading data recorded at an end of the real-time file before appending, the data comprising one or more GOPs, re-encoding the data which has been read, and recording the re-encoded data in a newly allocated pre-allocated area; and

a file structure processing section for designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent and for generating and recording the file management information.

67. An information recording apparatus according to claim 66, wherein each of the at least one pre-allocated area is allocated in physically contiguous sectors on an ECC block-by-ECC block basis.

68. An information recording apparatus according to claim 66, wherein the file management information comprises location information indicating each of the at least two real-time extents.

a linking controller for, responsive to a buffer underrun occurring during the recording of the real-time data, forming a linking gap in a real-time extent in which

the real-time data is recorded.

73. An information recording apparatus according to claim 72, wherein the linking loss extent comprises one ECC block.

74. An information recording apparatus according to claim 72, wherein the file management information comprises location information indicating each real-time extent.

75. An information recording apparatus according to claim 72, wherein the file management information comprises identification information for identifying the real-time file including real-time data.

76. An information recording apparatus according to claim 72,

wherein the linking controller records a data type bit in an area for recording physical additional information concerning each sector within the linking loss extent, the data type bit being used for identifying the linking loss extent; and

wherein the data type bit for the sector is set to 1 if a next sector is included within the linking loss extent, unless the sector is a linking sector.

77. An information recording apparatus according to claim 72, further comprising a runout controller for recording the real-time data in a runout area within the linking loss extent.

78. A system controller for an information recording apparatus for recording a real-time file containing

real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data, wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file;

wherein the system controller comprises a file system processing section for: allocating at least two areas satisfying a real-time reproduction condition from among a plurality of logically contiguous unused areas within the volume space, each of the at least two areas being designated as a pre-allocated area; recording the real-time data and the file management information; designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent; and generating the file management information for managing the real-time data as the real-time file,

wherein an $(i+1)^{\text{th}}$ pre-allocated area among the at least two pre-allocated areas is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{\text{out}},$$

wherein:

$T(i)$ represents a time required for the pickup to access from an end of an i^{th} pre-allocated area among the at least two pre-allocated areas to a beginning of an $(i+1)^{\text{th}}$

20250306 051504

pre-allocated area among the at least two pre-allocated areas;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} pre-allocated area to the beginning of the $(i+1)^{\text{th}}$ pre-allocated area, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} pre-allocated area, such that $D(i) = (V_{\text{in}} - V_{\text{out}}) \times S(i) / V_{\text{in}}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from the at pre-allocated are by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} pre-allocated area.

79. A system controller for an information recording apparatus for appending a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from

the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

the real-time data is recorded in at least one real-time extent each of which is allocated in logically contiguous sectors within the volume space,

wherein the system controller comprises:

a data amount calculation section for calculating whether or not each of the at least one real-time extent will cause an overflow in an amount of data stored in the buffer memory if the real-time extent is reproduced by the playback reference model; correcting the amount of data stored in the buffer memory to equal to or smaller than the size of the buffer memory when it is calculated that the real-time extent will cause an overflow; calculating whether or not an underflow will occur in the amount of data stored in the buffer memory if the playback reference model accesses from the real-time extent to a newly-allocated pre-allocated area; and searching for a real-time extent which will not cause an underflow, on accessing from the real-time extent to the pre-allocated area when it is calculated that an underflow will occur;

a data recording section for recording in the newly allocated pre-allocated area the real-time data already recorded in the real-time extent which will cause an underflow, and recording real-time data to be appended in the newly-allocated pre-allocated area; and

a file structure processing section for designating a set of logically contiguous sectors in which real-time data is recorded as a real-time extent and for generating and recording the file management information.

80. A method for reproducing a real-time file containing real-time data on an information recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

wherein the real-time data is recorded in at least two real-time extents each of which is allocated in logically contiguous sectors within the volume space; and

an $(i+1)^{\text{th}}$ real-time extent among the at least two real-time extents is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{\text{out}},$$

wherein:

$T(i)$ represents a time required for the pickup to access from an end of an i^{th} real-time extent among the at least two real-time extents to a beginning of the $(i+1)^{\text{th}}$ real-time extent;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} real-time extent to the beginning of the $(i+1)^{\text{th}}$ real-time extent, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

20250303 09:45:04

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the pickup reading the data from the i^{th} real-time extent, such that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from each of the at least two real-time extents by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} real-time extent,

wherein the method comprises the steps of:

reproducing the real-time file from the information recording medium by means of a disk drive;

acquiring location information of each of the at least two real-time extents and identification information indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition;

reading data from the at least two real-time extents at a data transfer rate which is equal to or greater than V_{in} of the playback reference model;

temporarily storing the real-time data which has been read in the buffer memory;

reading the data stored in the buffer memory and decoding the data in a decoder; and

accessing a next real-time extent within the time $T(i)$ of the playback reference model.

81. A method according to claim 80, wherein the file

reading the extended attribute from the file management information, and informing a reproduction mode to the disk drive based on the extended attribute prior to reproduction.

performing a reproduction operation for data recorded in a real-time extent, the reproduction operation being continuously performed without performing a recovery process even if a reproduction error due to invalid data recorded in the linking gap occurs.

83. An information reproduction apparatus for reproducing a real-time file containing real-time data on an information

recording medium in such a manner that the real-time data is continuously reproducible by a playback reference model, the real-time data comprising at least one of video data and audio data,

wherein the playback reference model includes:

a pickup for reading the real-time data from the information recording medium; a buffer memory for temporarily storing the real-time data read by the pickup; and a decoder module for reading the real-time data from the buffer memory for processing,

wherein the information recording medium comprises a volume space for at least recording in sectors a file comprising data and file management information for managing the file,

wherein the real-time data is recorded in at least two real-time extents each of which is allocated in logically contiguous sectors within the volume space; and

an $(i+1)^{\text{th}}$ real-time extent among the at least two real-time extents is positioned at a position satisfying a real-time reproduction condition defined as:

$$T(i) \leq (B(i-1) + D(i))/V_{\text{out}},$$

wherein:

$T(i)$ represents a time required for the pickup to access from an end of an i^{th} real-time extent among the at least two real-time extents to a beginning of the $(i+1)^{\text{th}}$ real-time extent;

$B(i)$ represents an amount of data having been stored in the buffer memory when the pickup accesses from the end of the i^{th} real-time extent to the beginning of the $(i+1)^{\text{th}}$ real-time extent, such that $B(i) = B(i-1) + D(i) - V_{\text{out}} \times T(i)$, assuming that $B(0) = 0$,

$D(i)$ represents an increase in the amount of data having been stored in the buffer memory responsive to the

2025 RELEASE UNDER E.O. 14176

pickup reading the data from the i^{th} real-time extent, such that $D(i) = (V_{in} - V_{out}) \times S(i) / V_{in}$, wherein $D(i)$ is corrected at least to a value equal to or smaller than $M - B(i-1)$ when $D(i) > M - B(i-1)$, where M represents a size of the buffer memory;

V_{out} represents a data transfer rate when the data is transferred from the buffer memory to the decoder module;

V_{in} represents a data transfer rate when the data is read from each of the at least two real-time extents by the pickup and transferred to the buffer memory; and

$S(i)$ represents a data size of the i^{th} real-time extent,

wherein the information reproduction apparatus comprises:

a disk drive for reproducing the real-time file from the information recording medium;

a file structure processing section for acquiring location information of each of the at least two real-time extents and identification information indicating that the at least two real-time extents are positioned in accordance with the real-time reproduction condition;

a data reproducer for reading data from the at least two real-time extents at a data transfer rate which is equal to or greater than V_{in} of the playback reference model;

a buffer memory for temporarily storing the real-time data which has been read; and

a decoder for reading the data stored in the buffer memory and decoding the data,

wherein a data reproduction performance which is determined as a function of an access performance and data transfer rate of the data reproducer and a size of the buffer memory satisfies a predetermined data reproduction performance of the playback reference model.

2025.05.14 09:00:00

a file structure processing section for determining whether or not the file is a real-time file containing real-time data; and

a data reproducer for performing a reproduction operation for data recorded in a real-time extent, the reproduction operation being continuously performed without performing a recovery process even if a reproduction error due to invalid data recorded in the linking gap occurs.

92030300